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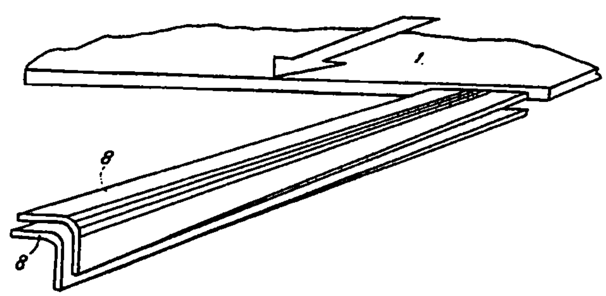

(57) Abstract

Method and apparatus for shaping, preferably bending, hardened flat wood fibre boards comprising cellulose fibers, lignin and hardening oil, by moistening, heating, bending and subsequent cooling. The boards (1) are fed continuously into a moistening apparatus in which, during their advance, the boards are moistened by a chemical solution applied to the upper and/or lower faces of the boards over the zones which are to be bent, subsequent to which the boards are heated by high-frequency energy at preferably 27 MHz to about 40-160°C simultaneously as they are bent or moulded to a desired predetermined shape in which shape the boards are maintained during cooling. An apparatus for bending the boards (1) includes at least one conveyor (2) for continuous advance of the boards to be bent, said conveyor (2) including, in the advancing direction of the boards, a moistening apparatus (3) for supplying a predetermined quantity of moisture to the upper and lower faces of the boards, a heating and shaping apparatus (4) comprising two forming surfaces (8) serving as electrodes and between which the boards can be advanced during simultaneous heating and shaping, and a cooling apparatus (5) in which the boards are fixed as to their shape during cooling.

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Method and apparatus for shaping, preferably bending, hardened wood fibre boards

The present invention relates to a method of shaping, preferably bending, hardened flat fibre boards consisting of cellulose fibres, lignin and hardening oil by moistening, heating bending and subsequent cooling.

Hardened wood fibre boards which comprise short brittle cellulose fibres and intermediate lignin as well as a percentage of cured hardening oil, which is a drying oil having the task of forming a bridgehead for so-called hydrogen bridges, can be bent principly in two different ways, namely using a high temperature or a low temperature combined with moisture.

In the use of the high temperature technique, the fibre boards are normally hardened during the manufacturing process at about 165°C. If the temperature is raised a few degrees above 165°C, the board will self-ignite in the presence of oxygen. In such a case the fibres are over-hardened, the hydrogen bridges are broken down and a carbonising process begins, which leads to rapid lowering of the board strength. If the lignin is therefore to be softened up at about 200°C in order to bend the board, this should take place in the absence of oxygen and preferably in an autoclave where steam under pressure is present to ensure the reformation of the hydrogen bridges. The board cannot be bent until it has been completely heated, which means that very hot contact plates are required if this is to take place rapidly with conventional heating, and so that the moisture will remain in the board. However, the heat from these plates breaks down the surface fibres before the heat has reached the middle of the board, should it be desired to have the moisture remaining in the board.

If heating is carried out more slowly and without the presence of moisture and oxygen, a complicated and expensive process is required where hydrogen gas or some other inert gas is continuously supplied.

In the use of the low temperature technique, attempts with high-frequency heating have surprisingly shown that the board already softens after about 8 seconds, in spite of the temperature still being comparatively low, about 40-70°C, and then further heating up to about 100°C it becomes so soft that it can be bent to a desired predetermined shape having very small radii. However, the process is entirely dependent on the presence of moisture. As soon as the board has dried out in the bending zones, it becomes stiff and brittle and quite impossible to bend any further. The bending process is thus dependent on the temperature of the board and the moisture content in the bending zones, energy quantity supplied during the bending preocess, remaining moisture content in the board and the rate of bending which is selected during the advance of the boards through the machine used for bending. All these factors are then also mutually independent, for example, a board which is too cold and stiff causes the electrodes used for the high-frequency heating to be forced apart or the boards are ruptured. A too low moisture content results in turn in that the high-frequency energy supplied becomes drastically less, giving a temperature which is too low and thus a board which is too stiff in the continued bending process, where the board continues to force apart the electrodes or it breaks up during advancing through the machine.

The object of the present invention is to achieve a continuous method and and an apparatus for controlled bending of wood fibres boards of the kind mentioned in the introduction, where the above-mentioned drawbacks

have been eliminated. The distinguishing features of the method and apparatus in accordance with the present invention are apparent from the accompanying claims.

As a result of the invention, the necessary moisture content inside the boards to enable bending them is obtained very rapidly by using a chemical solution for moistening. Compared with the use of pure water, penetration can be increased by about 100 times. Due to the high moisture content inside the bending zones achieved in this way, there is obtained a concentration of the supplied high-frequency energy simultaneously as such a high moisture content has ensured that the moisture is suffient during the whole of the bending operation during heating. This enables a continuous bending process in which the boards can be fed through the machine at a rate as high as 10-15 m per minute.

The invention will now be described in detail below with reference to the accommpanying drawing, on which

Fig. 1 schematically illustrates a machine, seen in plan, for the continuous bending of hardened wood fibre boards,

Fig. 2 is a schematic perspective view to an enlarged scale of two opposing shaping surfaces in the heating and shaping apparatus, and

Fig. 3 is a side view of the machine schematically illustrated in Fig. 1 and now shown in more detail.

As will be seen from the drawing, flat fibre boards which are to be shaped, preferably by bending, and comprising celloluse fibres, lignin and hardening oil are fed from the right into the machine by a feeding apparatus 9. The machine includes at least one conveyor 2 for continuously advancing the boards 1. After the feeding apparatus 9 at the beginning of the conveyor 2 there is a brush means 7 for brushing the advancing

boards 1 free from possible particles or for brushing to rough up the surface of the boards and remove wax substances to permit better penetration of moisture. Optionally via a preheating unit 6 the boards are then conveyed into a moistening apparatus 3 where the zone or zones of the boards 1 which are to be bent are moistened using the chemical solution, which is applied in a suitable way, e.g. by roller, brush spraying or the like, onto the upper and/or lower faces of the boards 1. In addition to water this solution suitably contains a surfactant and an alkali salt. The surfactant is preferably of the alkyl sulphate type and the alkali salt is preferably of the sodium hydroxide type. After the moistening apparatus 3 there is a heating and shaping apparatus 4 comprising two shaping surfaces 8 serving as electrodes, between which the boards 1 are advancable during simultaneous heating and bending. A pair of shaping surfaces 8 are schematically illustrated in Fig. 2, and they extend along one or both sides of the conveyor 2 in the advancing direction of the boards 1. A cooling apparatus 5 is situated after the heating and shaping apparatus 4, the boards being fixed as to their shape in the cooling apparatus while cooling. The shaping surfaces 8 in the heating and shaping apparatus 4 are suitably coated with a plastic material e.g. Teflon® which has low friction and low dielectic losses.

The method in accordance with the present invention for bending hardened wood fibre boards is carried out in the following manner. The boards 1 are advanced, preferably edge to edge after each other, from right to left as will be apparent from the drawing, and during conveyance on conveyor 2 the boards 1 will first arrive at the brushing apparatus 7, where the boards are brushed clean in the beding zones. Subsequently the boards 1 come into the preheating unit 6 for heating up to about 30-90°C,

preferably 60-80°C. During their travel, the boards are moistened with the chemical solution in the moistening apparatus 3 on their upper and/or lower faces over the zones which are to be bent, before the boards are fed into the heating and shaping apparatus 4, in which they are high-frequency heated at preferably 27 MHz to about 40-160°C, simultaneously as they are bent or moulded to the desired predetermined shape. In their bent shape the boards are then retained during cooling in the cooling device 5. After this, the boards are ready for conveyance to storage or place of use.

With regard to the chemical addition to the water, the combination of alkyl sulphates and sodium hydroxide give several positive effects, such as high penetration of the chemical solution into the boards, which is necessary for a continuous process. The alkaline additive causes swelling of the cellulose fibres, which suck up water rapidly in combination with low surface tension provided by the alkyl sulphate. The combination also achieves softening of the lignosulphonic acids in the boards in a similar way as for sulphate digestion. When the alkali is then neutralized by the acidic substances in the interior of the boards, the lignin hardens again after the bending process. The combination furthermore results in a concentration of the high-frequency energy. The boards, with their bending zones well penetrated by the chemical solution in accordance with the invention, give a very high loss factor, i.e. the high-frequency energy is concentrated to the moistened zones. The loss factor is doubled and the dielectrical constant increases, which indicates that the field is made more dense in the moistened area or areas on the boards.

As previously mentioned, in shaping the boards in the heating and shaping apparatus 4 they are fed continuously through the apparatus simultaneously as

they are heated. The boards preferably lie edge to edge after each other in the direction of travel, and are fed in between two shaping surfaces which are fixed in relation to the boards, and which also serve as electrodes for the high-frequency energy, the mutual spacing between the shaping surfaces being adjusted to the thickness of the boards which are to be bent. The shaping surfaces 8, see Fig. 2, which have the form of longitudinal gaps in the conveying direction, are arranged in the preferred embodiment on either side of the conveyor 2 in the heating and shaping apparatus 4, and these shaping surfaces 8 bend the side edge portions of the boards upwards or downwards so that they form an angle of about 90° to the chief plane of the boards.

Trials have shown that by performing preheating of the boards in the preheating unit 6, the agueous solution penetrates about 8 times quicker into the boards where the bending zones have been preheated before applying moisture. Moreover, there is thus avoided that the solution spreads along the plane of the boards and is instead concentrated to penetrating in depth in the bending zones.

CLAIMS

1. Method of shaping, preferably bending, hardened, flat wood fibre boards comprising cellulose fibres, lignin and hardening oil, by moistening, heating, bending and subsequent cooling, **characterized** in that the boards are fed continuously to a moistening apparatus, and in that during their travel the boards are moistened by a chemical solution applied to the upper and/or lower faces of the board over the zones which are to be bent, after which the boards are heated with the aid of high-frequency energy at preferably 27 MHz to about 40-160°C simultaneously as they are bent or moulded to the desired predetermined shape in which shape the boards are maintained during cooling.

2. Method as claimed in claim 1, **characterized** in that before advancing into the moistening apparatus the boards are preheated to about 30-90°C and preferably 60-80°C.

3. Method as claimed in claim 1, **characterized** in that the boards are moistened in the moistening apparatus to a moisture content approaching 12-17%.

4. Method as claimed in claim 1, **characterized** in that bending or moulding of the zones in question on the boards which are to be bent takes place continuously during the travel of the boards simultaneously as heating takes place, by boards, preferably lying edge to edge after each other in the direction of travel, being fed in between two shaping surfaces which are fixed relative the boards, the shaping surfaces also serving as electrodes for high-frequency energy and having a mutual spacing adjusted to the thickness of the boards to be bent.

5. Method as claimed in claim 4, **characterized** in

that the shaping surfaces are spring biased towards each other.

6. Apparatus for shaping, preferably bending hardened flat wood fibre boards (1) comprising cellulose fibres, ligning and hardening oil, by moistening, heating, bending and subsequent cooling, characterized by at least one conveyor (2) for continuous advance of the boards (1), said conveyor (2), as seen in the feed direction of the boards (2), including a moistening apparatus (3) for applying a predetermined amount of moisture to the upper and/or lower faces of the boards (1), a heating and shaping apparatus (4) comprising two forming surfaces serving as electrodes and between which the boards (1) can be advanced during simultaneous heating and moulding or bending, and a cooling apparatus (5) in which the boards are fixed to their shape during cooling.

7. Apparatus as claimed in 6, characterized in that the conveyor (2) includes a preheating unit (6) before the moistening unit (3), the boards being heatable in the preheating unit to about 30-90°C before applying the chemical solution.

8. Apparatus as claimed in claim 6, characterized in that the shaping surfaces are coated with a plastic material which has low friction and low dielectric losses.

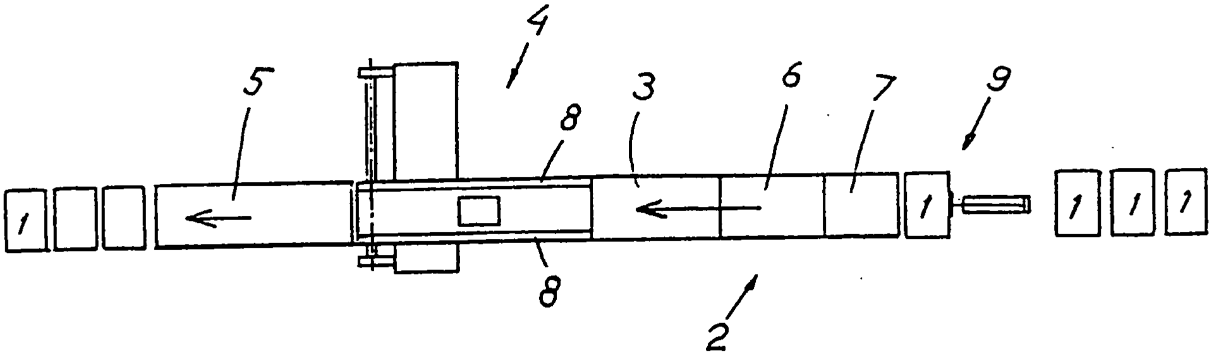

Fig. 1

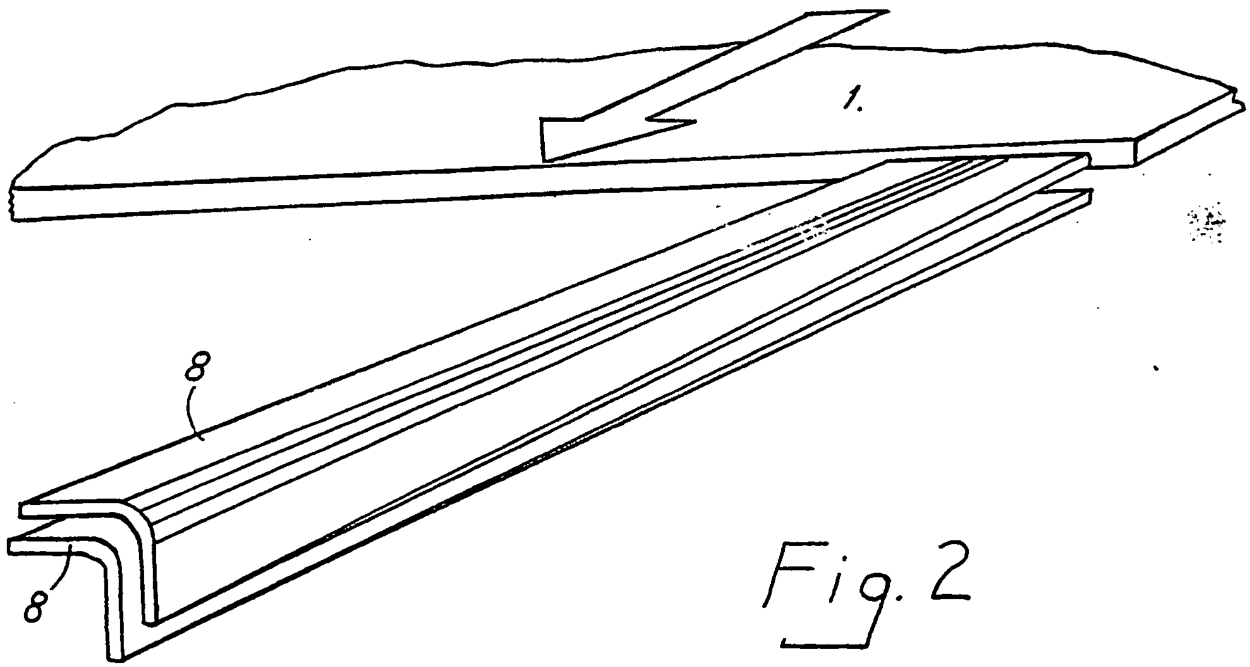

Fig. 2

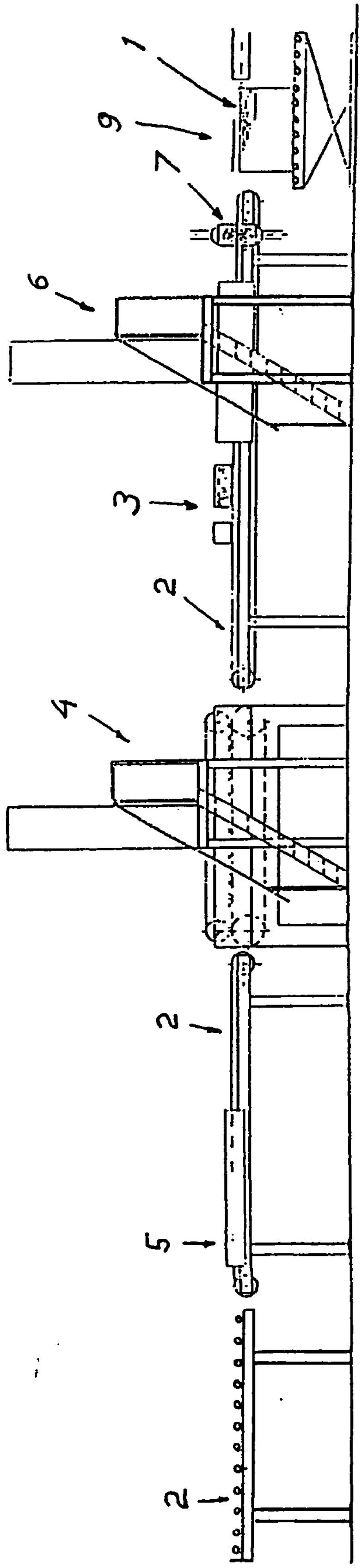

Fig. 3

INTERNATIONAL SEARCH REPORT

International Application No PCT/SE87/00160

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [6]

According to International Patent Classification (IPC) or to both National Classification and IPC

D 21 J 1/10 4

II. FIELDS SEARCHED

Minimum Documentation Searched [7]

Classification System	Classification Symbols
IPC	B 27 N 7/00; B 24 J 5/00; D 21 J 1/00, /10, /16
US Cl	144:317; 156:196, 219; 264:26, 322

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [8]

SE, NO, DK, FI classes as above

III. DOCUMENTS CONSIDERED TO BE RELEVANT [9]

Category *	Citation of Document, [11] with indication, where appropriate, of the relevant passages [12]	Relevant to Claim No. [13]
X	US, A, 2 595 501 (ALLIS-CHALMERS MANUFACTURING COMPANY) 6 May 1952	1, 6

* Special categories of cited documents: [10]

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IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
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